Cartesius-SD Series

Cartesian Robot User's Manual

P/N: EDS141 (Revision 1.01.00)

Dedicated to the Science of Motion
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Chapter 1: Overview

The Cartesius-SD series Cartesian robot is an industrial strength, multi-axis system that is built on the Aerotech Producer Series linear ballscrew stages. It is ideal for many automation applications including pick and place, assembly, test and inspection, dispensing stations, and many more.

Chapter 1 shows a typical Cartesius-SD positioning system. For this manual, “X axis” will refer to the base axis, “Y axis” will refer to the cross axis, and “Z axis” will refer the vertical axis. The X, Y, and Z axes are comprised of the PRO165, PRO115, and PRO115 respectively. The X and Y axes travel ranges from 150 to 600 mm and the Z axis from 50 mm to 300 mm.

This chapter introduces standard and optional features of the Cartesius-SD series, explains the model numbering system, and gives general safety precautions.

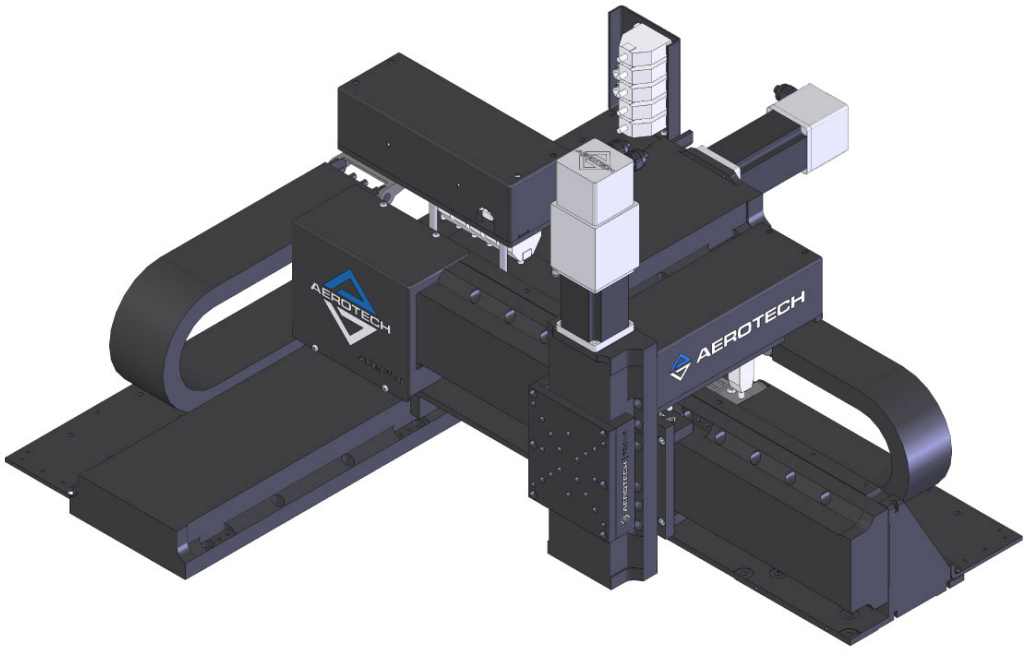


Figure 1-1: Typical Cartesius-SD Series Cartesian Robot

NOTE: Aerotech continually improves its product offerings, and listed options may be superseded at any time. Refer to the most recent edition of the Aerotech Motion Control Product Guide for the most current product information at www.aerotech.com.

1.1. Standard Features

A precision ground ballscrew and Linear Motion Guide (LMG) are standard features in all the axes of Cartesius-SD. The precision-ground, preloaded ballscrews ensure superior positioning resolution and accuracy while the LMG bearing systems provide stiffness, good load carrying capabilities, and continuous load support over the entire range of travel.

Cartesius-SD also includes a complete cable management system (CMS). Extensive R&D has resulted in an optimized CMS that has been field proven as the industry's most reliable design. Large bend radii and high-flex cables ensure that Cartesius-SD provides millions of cycles of maintenance free operation. In the unlikely event of a failure, a modular design ensures that part replacement is fast and easy.

Other standard design features include integral hardcovers and side seals to keep contamination out of the interior of the stages, and integral wipers on the ballscrew nut and bearing trucks to further reduce contamination. Optical limit switches and mechanical end stops, which protect the machine from over-travel, are also standard.

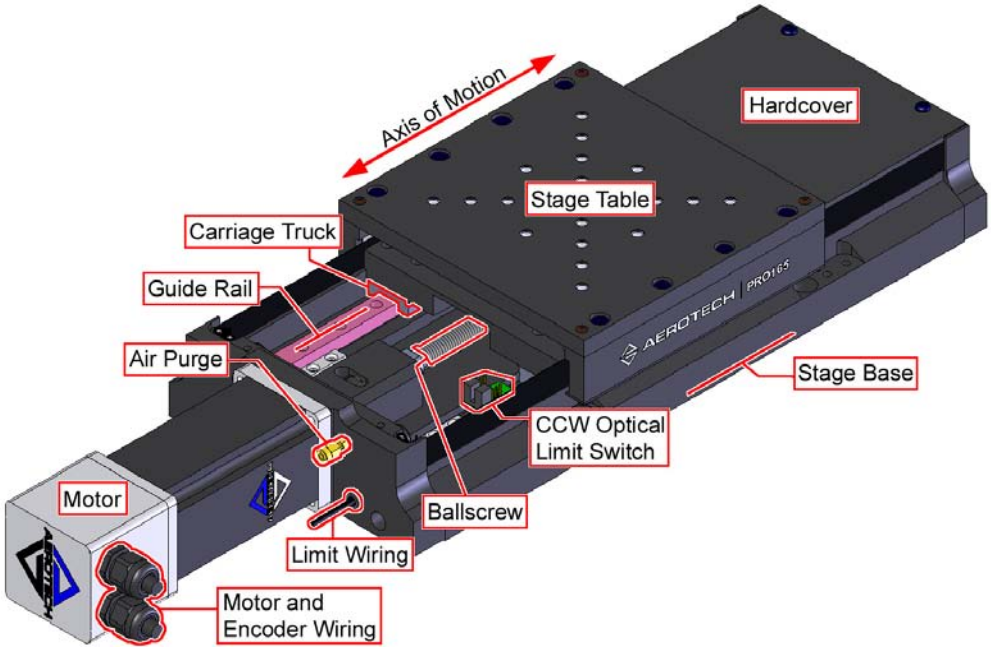


Figure 1-2: A single axis of the Cartesius-SD with Cutaway View of Ballscrew

1.1.1. Optional Features

Available assembly options allow Cartesius-SD to be configured for a variety of applications.

Cartesius-SD can be configured in either a right hand (-RH) or left hand (-LH) orientation. The Z axis is optional, so Cartesius-SD can be made as an XY or XYZ system. The travels of each axis can be matched in any combination. The X and Y axes can use either a 5mm or 20mm lead ballscrew. The axes can also be precision aligned to either 10 or 5 arc-sec orthogonality if needed. See Figure 1-3 and Figure 1-4 for examples of different arrangements available.

The stage table of the Y axis (or Z axis if ordered) is available with the mounting holes and grid pattern in either English (-TTU) or Metric (-TTM) dimensions.

Cartesius-SD systems can be ordered with a USER/IO option where Aerotech supplies (2) 6mm airlines and (1) 25 conductor signal cable through the stage cable management to the stage tabletop for easy integration. The signal cable can be supplied connectorized or with flying leads.

For vacuum applications, two vacuum preparation options are available upon request; one compatible with low vacuum environments (down to 10^{-3} torr) and the other for high vacuum (10^{-3} to 10^{-6} torr) applications.

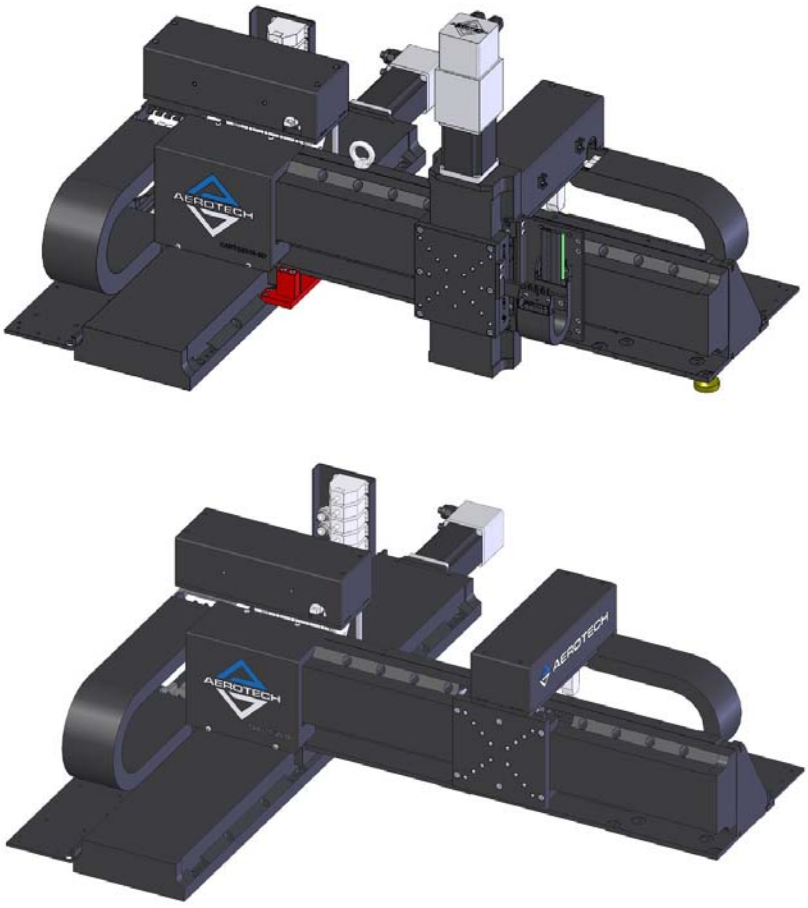


Figure 1-3: Right Hand XYZ with Cable Management System (top) and XY (bottom) Assemblies

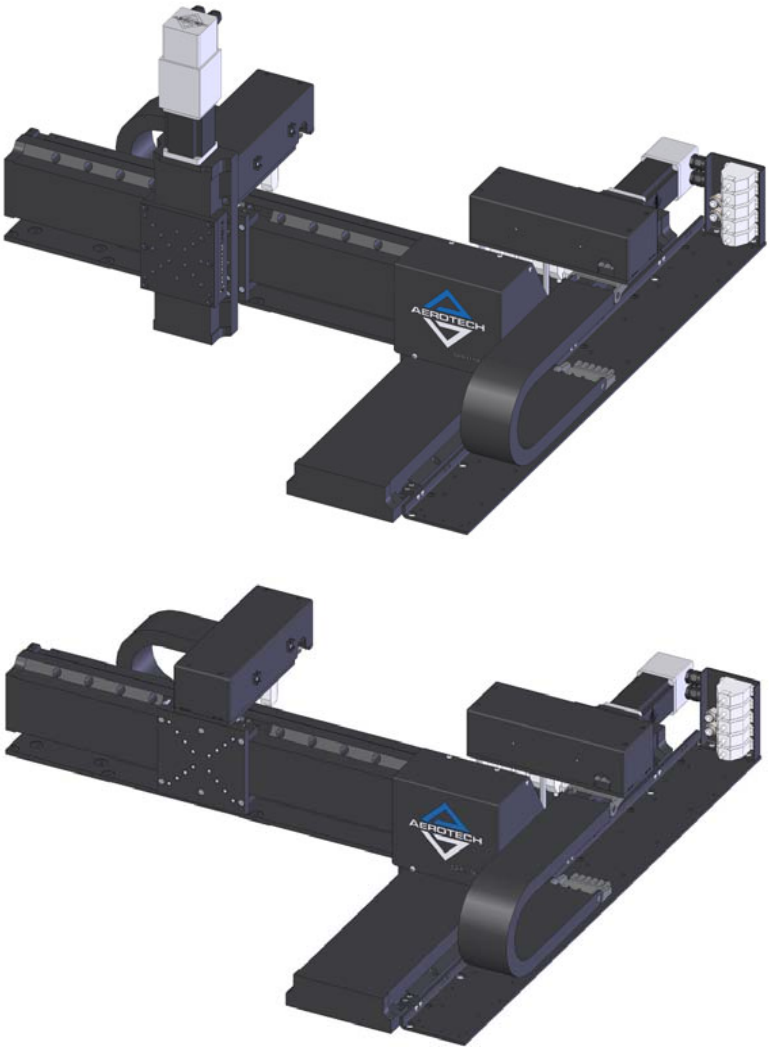


Figure 1-4: Left Hand XYZ (top) and XY (bottom) Assemblies

1.1.2. Model Numbers

System model number example: CARTESIUS-SD-RH-X-20MM-300-Y-20MM-300-YCMS-Z-05MM-050-ZCMS-TTMZ-USER-IO-SUBD

The table below lists the available options in the order they appear in the example above. Aerotech continually improves its product offerings, and listed options may be superseded at any time. Refer to the most recent edition of the Aerotech Motion Control Product Guide for the most current product information at www.aerotech.com.

Table 1-1: Model Numbering System

Orientation	
-RH	Right hand configuration
-LH	Left hand configuration
X Axis Options	
-X-20MM-150	150 mm (6 in) travel, 20mm lead ballscrew stage
-X-20MM-200	200 mm (8 in) travel, 20mm lead ballscrew stage
-X-20MM-250	250 mm (10 in) travel, 20mm lead ballscrew stage
-X-20MM-300	300 mm (12 in) travel, 20mm lead ballscrew stage
-X-20MM-400	400 mm (16 in) travel, 20mm lead ballscrew stage
-X-20MM-500	500 mm (20 in) travel, 20mm lead ballscrew stage
-X-05MM-250	250 mm (10 in) travel, 5mm lead ballscrew stage
-X-05MM-300	300 mm (12 in) travel, 5mm lead ballscrew stage
-X-05MM-400	400 mm (16 in) travel, 5mm lead ballscrew stage
-X-05MM-500	500 mm (20 in) travel, 5mm lead ballscrew stage
-X-05MM-600	600 mm (24 in) travel, 5mm lead ballscrew stage
Y Axis Options	
-Y-20MM-150	150 mm (6 in) travel, 20mm lead ballscrew stage
-Y-20MM-200	200 mm (8 in) travel, 20mm lead ballscrew stage
-Y-20MM-250	250 mm (10 in) travel, 20mm lead ballscrew stage
-Y-20MM-300	300 mm (12 in) travel, 20mm lead ballscrew stage
-Y-20MM-400	400 mm (16 in) travel, 20mm lead ballscrew stage
-Y-20MM-500	500 mm (20 in) travel, 20mm lead ballscrew stage
-Y-05MM-250	250 mm (10 in) travel, 5mm lead ballscrew stage
-Y-05MM-300	300 mm (12 in) travel, 5mm lead ballscrew stage
-Y-05MM-400	400 mm (16 in) travel, 5mm lead ballscrew stage
-Y-05MM-500	500 mm (20 in) travel, 5mm lead ballscrew stage
-Y-05MM-600	600 mm (24 in) travel, 5mm lead ballscrew stage
-Y-20MM-150-YCMS	150 mm (6 in) travel, 20mm lead ballscrew stage and cable management
-Y-20MM-200-YCMS	200 mm (8 in) travel, 20mm lead ballscrew stage and cable management
-Y-20MM-250-YCMS	250 mm (10 in) travel, 20mm lead ballscrew stage and cable management
-Y-20MM-300-YCMS	300 mm (12 in) travel, 20mm lead ballscrew stage and cable management

Table 1-1: Model Numbering System (continued)

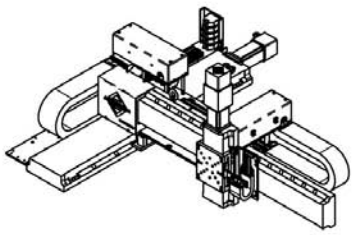
-Y-20MM-400-YCMS	400 mm (16 in) travel, 20mm lead ballscrew stage and cable management
-Y-20MM-500-YCMS	500 mm (20 in) travel, 20mm lead ballscrew stage and cable management
-Y-05MM-250-YCMS	250 mm (10 in) travel, 5mm lead ballscrew stage and cable management
-Y-05MM-300-YCMS	300 mm (12 in) travel, 5mm lead ballscrew stage and cable management
-Y-05MM-400-YCMS	400 mm (16 in) travel, 5mm lead ballscrew stage and cable management
-Y-05MM-500-YCMS	500 mm (20 in) travel, 5mm lead ballscrew stage and cable management
-Y-05MM-600-YCMS	600 mm (24 in) travel, 5mm lead ballscrew stage and cable management
Z Axis Options	
-NOZ	No Z-axis
-Z-05MM-050	50 mm (2 in) travel, 5mm lead ballscrew stage
-Z-05MM-100	100 mm (4 in) travel, 5mm lead ballscrew stage
-Z-05MM-150	150 mm (6 in) travel, 5mm lead ballscrew stage
-Z-05MM-200	200 mm (8 in) travel, 5mm lead ballscrew stage
-Z-05MM-250	250 mm (10 in) travel, 5mm lead ballscrew stage
-Z-05MM-300	300 mm (12 in) travel, 5mm lead ballscrew stage
-Z-05MM-050-ZCMS	50 mm (2 in) travel, 5mm lead ballscrew stage and cable management
-Z-05MM-100-ZCMS	100 mm (4 in) travel, 5mm lead ballscrew stage and cable management
-Z-05MM-150-ZCMS	150 mm (6 in) travel, 5mm lead ballscrew stage and cable management
-Z-05MM-200-ZCMS	200 mm (8 in) travel, 5mm lead ballscrew stage and cable management
-Z-05MM-250-ZCMS	250 mm (10 in) travel, 5mm lead ballscrew stage and cable management
-Z-05MM-300-ZCMS	300 mm (12 in) travel, 5mm lead ballscrew stage and cable management
Tabletop Options	
-TTMY	Metric hole-pattern tabletop for XY system
-TTUY	English hole-pattern tabletop for XY system
-TTMZ	Metric hole-pattern tabletop for XYZ system
-TTUZ	English hole-pattern tabletop for XYZ system
User I/O	
-USER-IO-NONE	No User I/O option
-USER-IO-DSUB	(2) 6mm airlines and (1) customer I/O cable provided with mated 25 pin D connector at the stage carriage
-USER-IO-FLY	2) 6mm airlines and (1) customer I/O cable provided with flying leads at the stage carriage
-USER-IO-ROTARY	Wiring for rotary axis
Accessories (to be ordered as separate line item)	
ALIGNMENT-PA10	XY assembly; 10 arc sec orthogonal
ALIGNMENT-PA10Z	XYZ assembly; 10 arc second orthogonal
ALIGNMENT-PA5	XY assembly; 5 arc sec orthogonal
ALIGNMENT-PA5Z	XYZ assembly; 5 arc second orthogonal
HDR165-100	Riser, 100mm Tall
HDR165-300	Riser, 300mm Tall

1.2. Dimensions

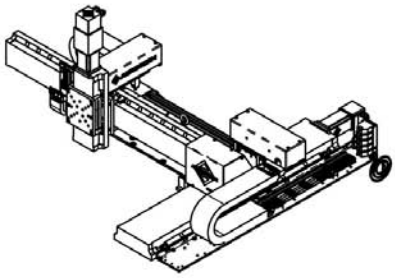
X-AXIS			
STAGE		A	B
PRO165-05MM-250	PRO165-20MM-150	486	409.9
PRO165-05MM-300	PRO165-20MM-200	536	434.9
	PRO165-20MM-250	586	459.9
PRO165-05MM-400	PRO165-20MM-300	636	484.9
PRO165-05MM-500	PRO165-20MM-400	736	534.9
PRO165-05MM-600	PRO165-20MM-500	836	584.9

Y-AXIS				
STAGE		C	D	E
PRO115-05MM-250	PRO115-20MM-150	307.5	737.5	-
PRO115-05MM-300	PRO115-20MM-200	332.5	787.5	-
	PRO115-20MM-250	357.5	837.4	-
PRO115-05MM-400	PRO115-20MM-300	382.5	887.4	-
PRO115-05MM-500	PRO115-20MM-400	432.5	987.4	300
PRO115-05MM-600	PRO115-20MM-500	482.5	1087.4	400

OPTIONAL Z-AXIS		
STAGE	F	G
PRO115-05MM-050	286	170
PRO115-05MM-100	336	195
PRO115-05MM-150	386	220
PRO115-05MM-200	436	245
PRO115-05MM-250	486	270
PRO115-05MM-300	536	295



RIGHT HAND (-RH) CONFIGURATION



LEFT HAND (-LH) CONFIGURATION

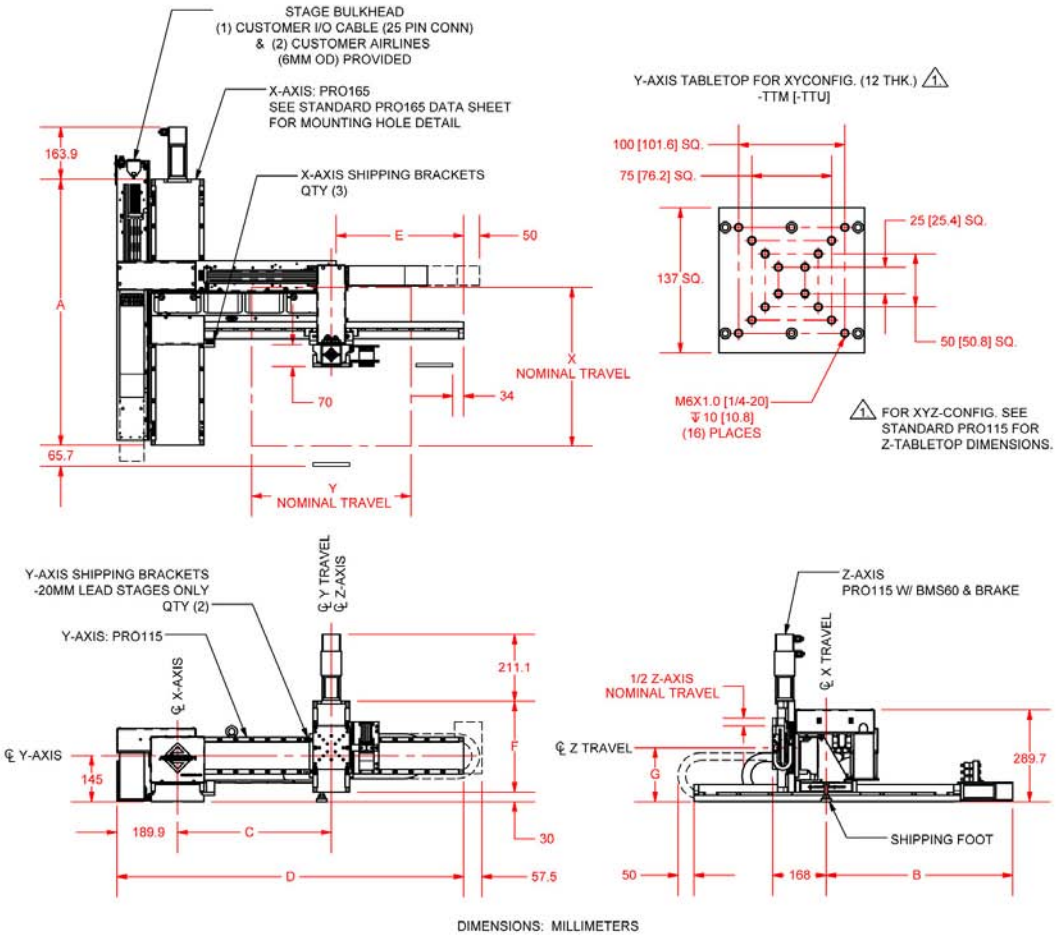


Figure 1-5: Cartesius-SD Dimensions

1.3. Safety Procedures and Warnings

The following statements apply throughout this manual. Failure to observe these precautions could result in serious injury to those performing the procedures and damage to the equipment.

This manual and any additional instructions included with the stage should be retained for the lifetime of the stage.

	To minimize the possibility of electrical shock and bodily injury or death, disconnect all electrical power prior to making any electrical connections.
	To minimize the possibility of electrical shock and bodily injury or death when any electrical circuit is in use, ensure that no person comes in contact with the circuitry when the stage is connected to a power source.
	To minimize the possibility of bodily injury or death, disconnect all electrical power prior to making any mechanical adjustments.
	Moving parts of the stage can cause crushing or shearing injuries. All personnel must remain clear of any moving parts.
	Improper use of the stage can cause damage, shock, injury, or death. Read and understand this manual before operating the stage.
	If the stage is used in a manner not specified by the manufacturer, the protection provided by the stage can be impaired.
	Stage cables can pose a tripping hazard. Securely mount and position all stage cables to avoid potential hazards.

Do not expose the stage to environments or conditions outside the specified range of operating environments. Operation in conditions other than those specified can cause damage to the equipment.

The stage must be mounted securely. Improper mounting can result in injury and damage to the equipment.

Use care when moving the stage. Manually lifting or transporting stages can result in injury.

Only trained personnel should operate, inspect, and maintain the stage.

This stage is intended for light industrial manufacturing or laboratory use. Use of the stage for unintended applications can result in injury and damage to the equipment.

Before using this stage, perform an operator risk assessment to determine the needed safety requirements.

1.4. EC Declaration of Incorporation

Manufactorer: Aerotech, Inc.
101 Zeta Drive
Pittsburgh, PA 15238
USA

herewith declares that the product:
Aerotech, Inc. Cartesius-SD Stage
is intended to be incorporated into machinery to constitute machinery covered by the Directive 2006/42/EC as amended;

does therefore not in every respect comply with the provisions of this directive;

and that the following harmonized European standards have been applied:
EN ISO 12100-1,-2:2003+A1:2009
Safety of machinery - Basic concepts, general principles for design
ISO 14121-1:2007
Safety of machinery - Risk assessment - Par 1: Principles
EN 60204-1:2005
Safety of machinery - Electrical equipment of machines - Part 1: General requirements
and further more declares that
it is not allowed to put the equipment into service until the machinery into which it is to be incorporated or of which it is to be a component has been found and declared to be in conformity with the provisions of the Directive 2006/42/EC and with national implementing legislation, i.e. as a whole, including the equipment referred to in this Declaration.

Authorized Representative: Manfred Besold
Address: AEROTECH GmbH
Süd-West-Park 90
D-90449 Nürnberg

Name: Alex Weibel /
Position: Engineer Verifying Compliance
Location: Pittsburgh, PA
Date: November 29, 2010

Chapter 2: Installation

This chapter describes the installation procedure for the Cartesius-SD stage, including handling the stage properly, preparing the mounting surface, securing the stage to the mounting surface, attaching the payload, and making the electrical connections.

Installation must follow the instructions in this chapter. Failure to follow these instructions could result in injury and damage to the equipment.

2.1. Unpacking and Handling the System

Carefully remove the system from the protective shipping container. Use the provided eyebolt to lift the assembly. The lifting eyebolt should be removed before operating the system. Set the system on a smooth, flat, and clean surface. This is a simple, yet very important step in maintaining the integrity of the system. A leveling foot is attached to the Y axis bracket for support during shipping. **The leveling foot must be removed before operating the system.** If any damage has occurred during shipping, report it immediately.

Each stage has a label listing the system part number and serial number. These numbers contain information necessary for maintaining or updating system hardware and software. Locate this label and record the information for later reference. If any damage has occurred during shipping, report it immediately.

Improper system handling could adversely affect the stage's performance. Use care when moving the system. Manually lifting or transporting the system can result in injury.

Do not use the ballscrew or motor as lifting points.

2.2. Preparing the Mounting Surface

The mounting surface should be flat and have adequate stiffness in order to achieve the maximum performance from the Cartesius-SD. When a stage is mounted to a non-flat surface, the stage can be distorted as the mounting screws are tightened. See Figure 2-1.

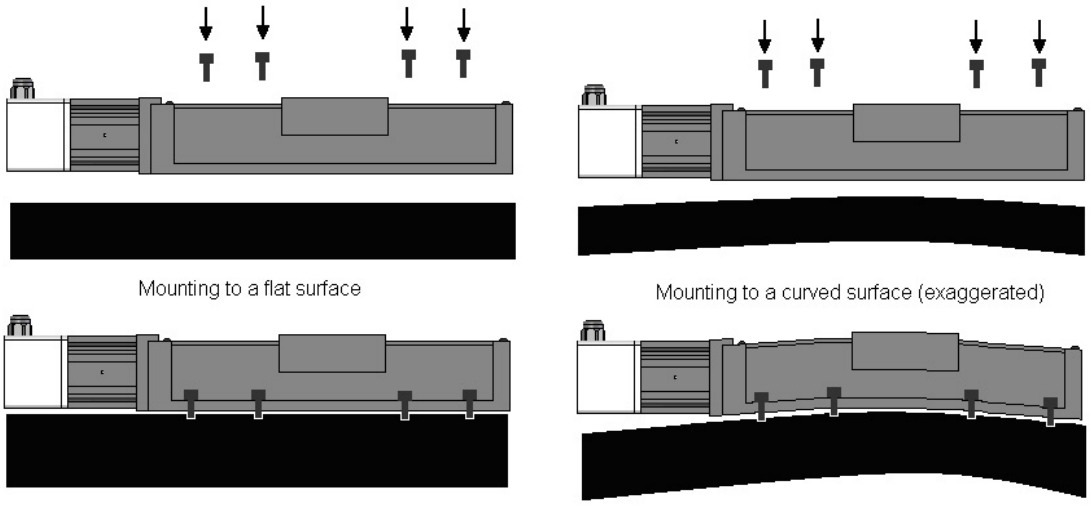


Figure 2-1: Results of Flat Versus Non-Flat Mounting

NOTE: To maintain accuracy, the mounting surface should be flat, as specified in Table 2-1.

Any distortion will decrease the overall accuracy of the system. Aerotech recommends stoning the mounting surface and the X axis stage base with precision flat stones prior to mounting the system to the mounting surface to remove any local high spots or imperfections in the surfaces. Adjustments to the mounting surface must be done before the system is secured. If Aerotech HDR165 risers have been ordered as part of the Cartesius system, in order to achieve desired accuracy, the flatness requirement must be observed as it would for a standard X-axis stage.

NOTE: The stage base is precision machined and verified for flatness prior to stage assembly at the factory. If machining is required to achieve the desired flatness, it should be performed on the mounting surface rather than the stage base. Shimming should be avoided if possible. If shimming is required, it should be minimized to improve the rigidity of the system.

Table 2-1: Stage Mounting Surface Flatness Requirement

X Axis Stage Travel	Flatness Requiement
150-300 mm	5 µm
400-600 mm	7.5 µm

2.3. Shipping Brackets

Cartesius-SD's X axis comes equipped with shipping brackets. There are also shipping brackets on the Y axis if it has a 20mm lead ballscrew. Both sets are shown in Figure 2-2.

Remove the shipping brackets once the stage has been placed on the mounting surface. The X axis shipping bracket is composed of three pieces. Remove the vertical block at the opposite end of the X axis motor first. It is secured by two M5x0.8 socket head cap screws (SHCS). Then, manually translate the X axis table away from the motor to access and remove the second vertical shipping block which is also secured by two M5x0.8 SHCS. The shipping bracket base can then be removed by removing the four M4x0.7 SHCS.

The Y axis brackets are mounted in place with two M4x0.7 socket head cap screws. Retain all shipping brackets for future use.

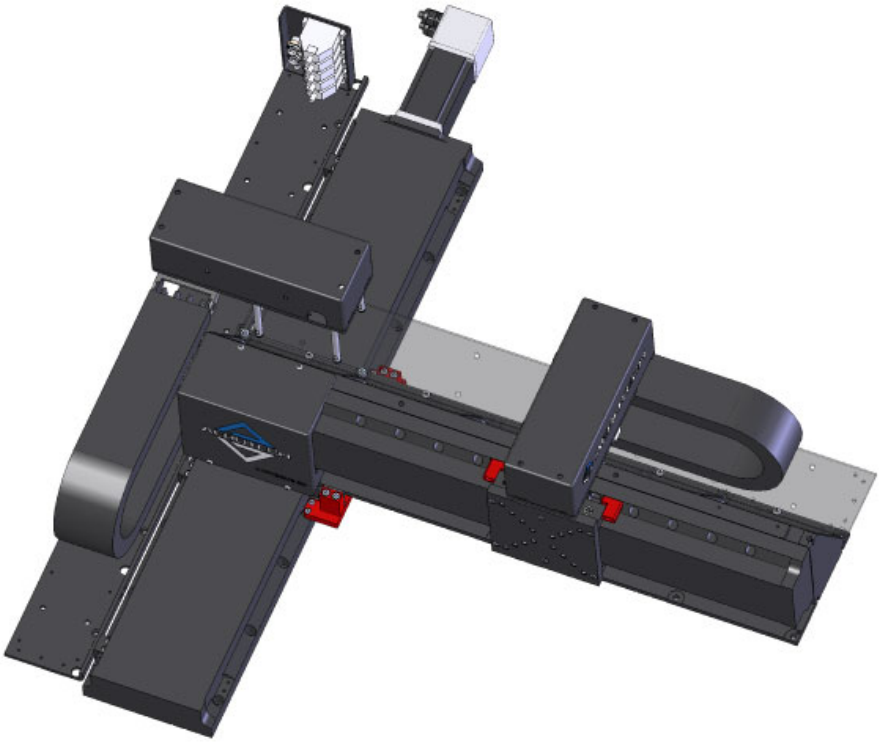


Figure 2-2: Shipping Bracket Locations

2.4. Securing the System to the Mounting Surface

If necessary, manually move the X axis stage table to access the 6.5 mm (0.28 in) diameter mounting holes along the edges of the X axis stage (refer to Figure 2-3). This stage is designed to use socket head cap screws (SHCS) to secure the base to the mounting surface. Use M6 x 22 mm or 1/4 x 7/8" long SHCS to achieve 1.5x diameter thread engagement. Torque the mounting screws to 8.1 N*m (6 ft*lb).

NOTE: The stage table may offer a considerable amount of resistance when it is moved manually. This is especially true if the stage is fitted with a motor assembly.

NOTE: If the stage is not connected to a power source, and not equipped with an optional brake, it should be possible to move the stage table by hand with steady even pressure. Do not attempt to manually move the stage if it is connected to a power source or includes an integrated brake.

The system must be mounted securely. Improper mounting can result in injury and damage to the equipment.

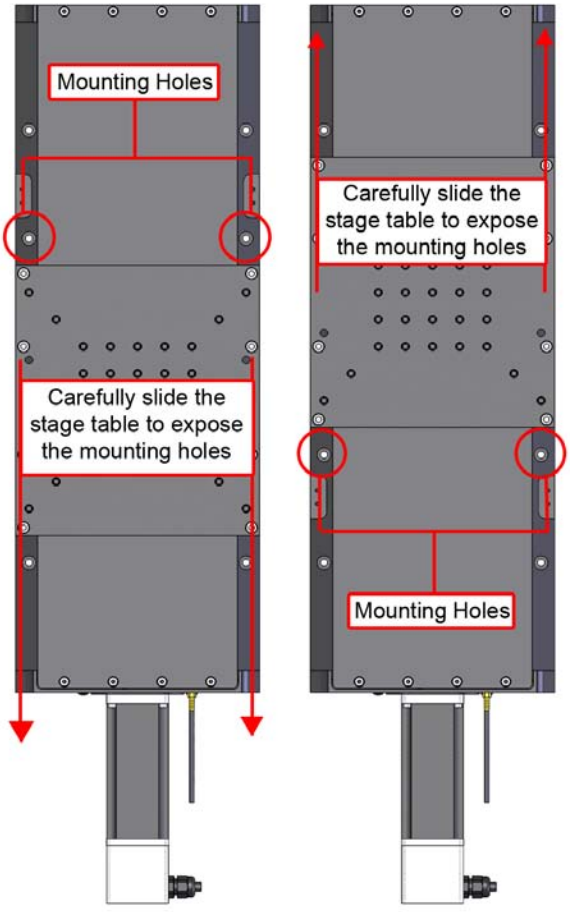

Mounting Holes
Carefully slide the stage table to expose the mounting holes
Carefully slide the stage table to expose the mounting holes
Mounting Holes

Figure 2-3: Mounting Hole Locations on X Axis

2.5. Attaching the Payload to the System

To prevent damage to delicate payloads, test the operation of the system before attaching the payload to the table. Proceed with the electrical installation and test the motion control system in accordance with the system documentation. Document all results for future reference. For information on electrical connections, refer to Section 2.6. Electrical Installation.

The payload should be flat, rigid, and comparable to the system in quality.

NOTE: For valid accuracies, the mounting interface should be flat within 1 µm per 50 mm.

Do not attach a payload to the stage table with screws that are too long. A screw passing through the stage table can come into contact with the hardcover, affecting travel and possibly damaging the stage.

2.6. Electrical Installation

Electrical installation requirements will vary depending on system options. Installation instructions in this section are for systems equipped with standard Aerotech motors intended for use with an Aerotech motion control system. Contact Aerotech for further information regarding systems that are otherwise configured.

Aerotech motion control systems are adjusted at the factory for optimum performance. When the Cartesius-SD series system is part of a complete Aerotech motion control system, setup involves connecting the system to the appropriate drive chassis with the cables provided. Connect the provided cables to the motor and feedback connectors on the Cartesius-SD. Labels on the drive indicate the appropriate connections. Refer to your drive manuals and documentation for additional installation and operation information. In some cases, if the system is uniquely configured, a drawing showing system interconnects is supplied.

Never connect or disconnect any electrical component or connecting cable while power is applied, or serious damage may result.

The stage's protective ground is located on pin A4 of the motor connector. If you are using cables other than those provided by Aerotech, you must connect pin A4 to a ground connection.

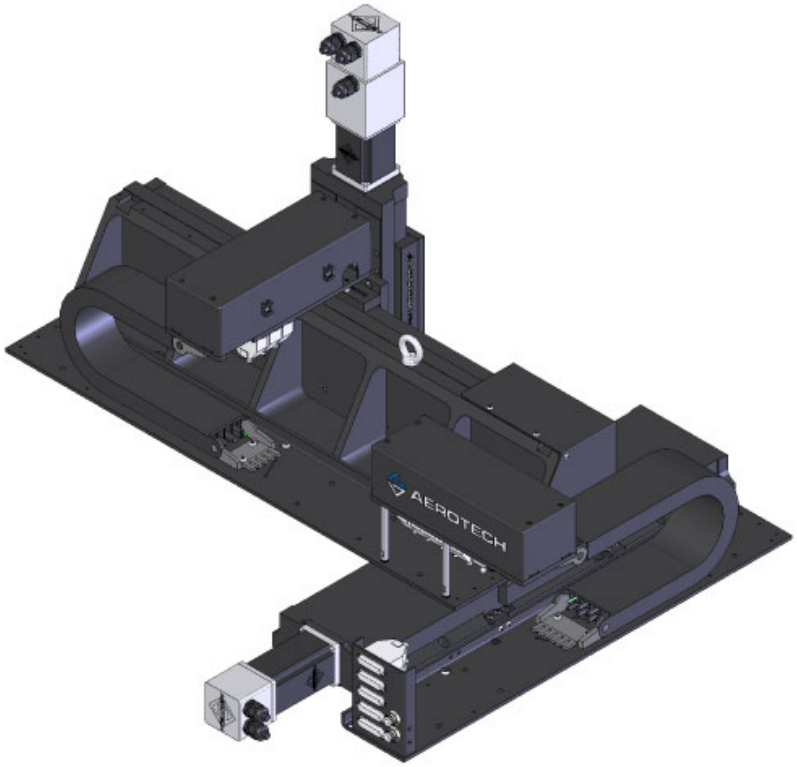


Figure 2-4: Components of a Typical Stage

2.6.1. Standard Aerotech Motor Options

Aerotech's high performance brushless rotary motors are the standard motors for all axes of Cartesius-SD. The BM130 and BMS100 are standard for the X-axis (PRO165). The BM75 and BMS60 are the standard motors for the Y and Z axes (PRO115), with the Z-axis motor always supplied with a brake. The electrical wiring from the motor and encoder to the "connectorized" ports on the motor can is contained within the rear motor housing and has been completed at the factory. The motor cables and limit cable convey motor power, encoder feedback, and limit switch signals to an appropriate hardware device (e.g. axis controller or amplifier). Refer to Section 3.7. for standard motor wiring and connector pin outputs.

2.6.2. Optical Limit Switches

Each axis of Cartesius-SD is equipped with a pair of optical limit switches: one at each end of nominal travel. The limit switches can be configured as normally closed (NC) or normally open (NO). On the X axis stage, the limit cable exits the stage on the same side as the motor and is bundled with the other system cables. For the Y and Z axis stages, the limit cable is wired into the feedback cable. Refer to Section 3.6. for a description of limit switch operation and wiring.

Chapter 3: Operating Specifications

The surrounding environment and operating conditions can affect the performance and service life of the system. This chapter provides information on ideal environmental and operating conditions. Also included are instructions for estimating load capability.

3.1. Environmental Specifications

The environmental specifications for the Cartesius-SD are listed in the following table.

Table 3-1: Environmental Specifications

Ambient Temperature	Operating: 10° to 35° C (50° to 95° F) The optimal operating temperature is 20° C ±2° C (68° F ±4° F). If at any time the operating temperature deviates from 20° C degradation in performance could occur. Contact Aerotech for information regarding your specific application and environment.
	Storage: 0° to 40° C (32° to 104° F) in original shipping packaging
Humidity	Operating: 40 percent to 60 percent RH The optimal operating humidity is 50 percent RH.
	Storage: 30 percent to 60 percent RH, non-condensing in original packaging
Altitude	Operating: 0 to 2,000 m (0 to 6,562 ft) above sea level Contact Aerotech if your specific application involves use above 2,000 m or below sea level.
Vibration	Use the system in a low vibration environment. Excessive floor or acoustical vibration can affect stage and system performance. Contact Aerotech for information regarding your specific application.
Dust Exposure	The Cartesius-SD has limited protection against dust, but not water. This equates to an ingress protection rating of IP50.
Use	Indoor use only

Do not expose the stage to environments or conditions outside the specified range of operating environments. Operation in conditions other than those specified can cause damage to the equipment.

3.2. Accuracy and Temperature Effects

The accuracy specification of Cartesius-SD series robot is measured at the center of travel 25 mm above the table. The system is assumed to be fully supported by a mounting surface meeting or exceeding the specification in Table 2-1.

The accuracy of the ballscrew is a key element in the overall positioning accuracy. A scale error on each axis can be expected if temperature of the ballscrew differs from 20° C (68° F). The greater the temperature difference, the greater the error. The temperature of the ballscrew depends on the speed and duty cycle of the axis. The faster the movement and higher the duty cycle, the more the stage accuracy will be affected by heat. The thermal expansion coefficient of the ballscrew is 11.7 ppm/°C.

3.3. Basic Specifications

Specifications for the Cartesius-SD series positioning system are not included in this manual. For more detailed information, see the individual axis (PRO165 or PRO115) manuals.

3.4. Load Capability

The Cartesius-SD's load capability will vary widely depending on the number of axes, the individual axes' lengths/leads, the payload's size/location, and the move profile. Each case should be confirmed with Aerotech as acceptable. For reference, all Cartesius-SD configurations can handle a centered (non-offset) 5 kg load. Systems with shorter travel axes or XY assemblies will have a greater load capability.

3.5. Optical Limit Switch

Each Cartesius-SD axis is provided with a pair of optical limit switch assemblies mounted to the base of the stage. The limit switches signal when the axis has reached its maximum useable travel distance in both directions.

3.5.1. Limit Switch Operation

Each limit switch has a light source and detector mounted to a small printed circuit board. Each limit switch board is mounted at an end of the stage with its emitter–detector axes perpendicular to the direction of table motion. On a standard stage, the clockwise (CW) switch is located at the end opposite the motor. When movement of the stage table causes the blade mounted to the stage carriage to break the light beam from the emitter to the detector, a CW or counterclockwise (CCW) limit signal is generated. The limit switch itself can be configured as normally closed (NC) or normally open (NO).

If the stage is driven past the electrical limit, it will encounter the hard stop. Where the hard limit occurs is dependent on stage travel. Although the operating speed of the stage may be relatively slow, and the stage's shocks will provide some protection, damage to the stage could result.

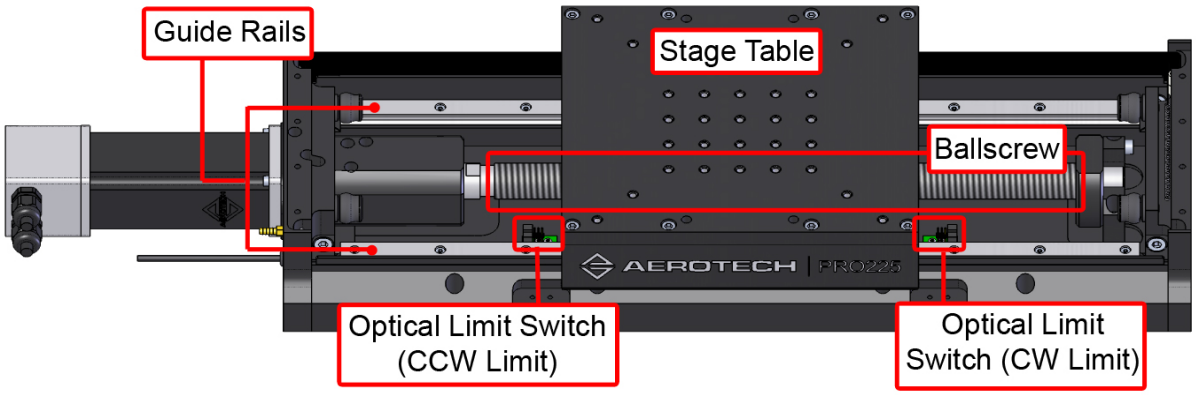


Figure 3-1: Internal View of a Typical Stage Showing Limit Switches

NOTE: Clockwise (CW) and counterclockwise (CCW) refer to the direction of motor rotation while looking into the shaft of the motor. CW rotation of the motor causes the stage table to move away from the motor. CCW rotation of the motor causes the stage table to move toward the motor.

3.6. Limit Switch Wiring

Limit switches are open-collector, TTL–compatible, electro–optical devices powered by 5 Volts that change output states when the stage approaches its maximum travel distance and breaks the light beam. Since they are open-collector devices, they may be interfaced to 24 Volt logic inputs. Each limit switch is mounted on a small printed circuit board. Standard stages include wiring in a separate 9-pin limit switch connector, detailed in Figure 3-2.

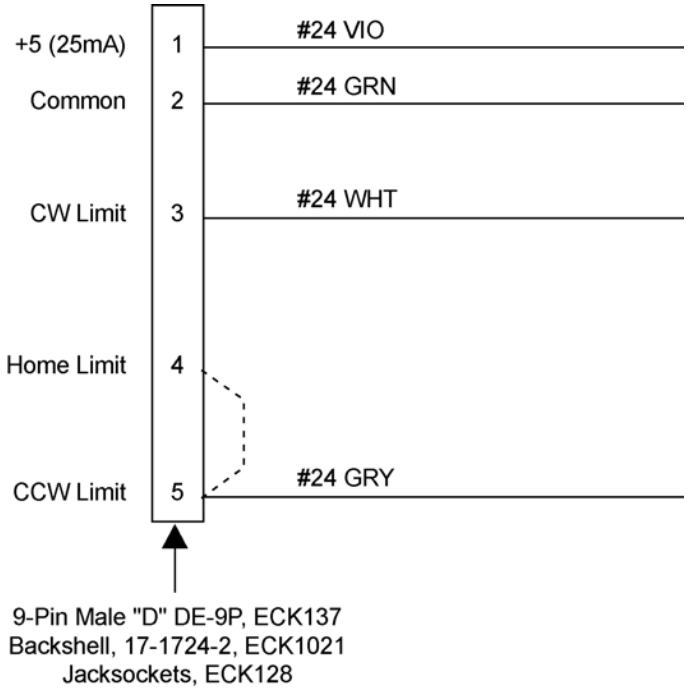


Figure 3-2: Series 9-pin Limit Switch Wiring

Assuming a NC limit configuration, the input to the controller is seen as a logic 0 (typical 0.4V @ 12.8 mA) when no limit condition is present. When the limit switch is activated, a 5V source through a pull-up resistor, on the controller, causes a logic 1 (typically 4.8-5 V) to be seen by the controller input. The limit switch operation for a NO limit configuration is the exact opposite as described above. See Figure 3-3 for a diagram of limit switch wiring.

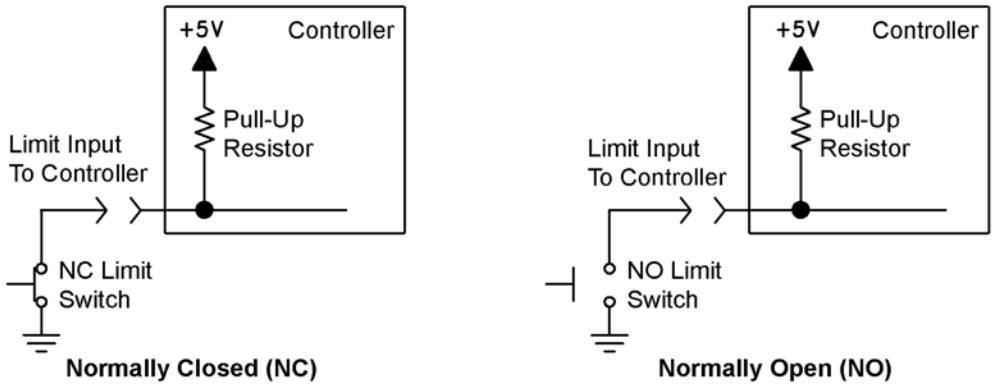


Figure 3-3: Normally Closed (NC) and Normally Open (NO) Limit Switch Wiring

3.7. Standard Motor Wiring

Stages fitted with standard motors and encoders come from the factory completely wired and assembled. For reference, connector pin outputs and general wiring information is given in the following figures and tables. Pin outputs are defined in 3.7 and 3.7.

NOTE: Refer to the other documentation accompanying your Aerotech equipment. Call your Aerotech representative if there are any questions on system configuration.

NOTE: If you are using your own cables to connect the stage, ensure that motor and ground wires can handle current higher than the continuous motor current listed in the individual axis (PRO165 or PRO115) manuals. The voltage rating of the wire insulation must be higher than the maximum drive output voltage listed in the individual axis (PRO165 or PRO115) manuals.

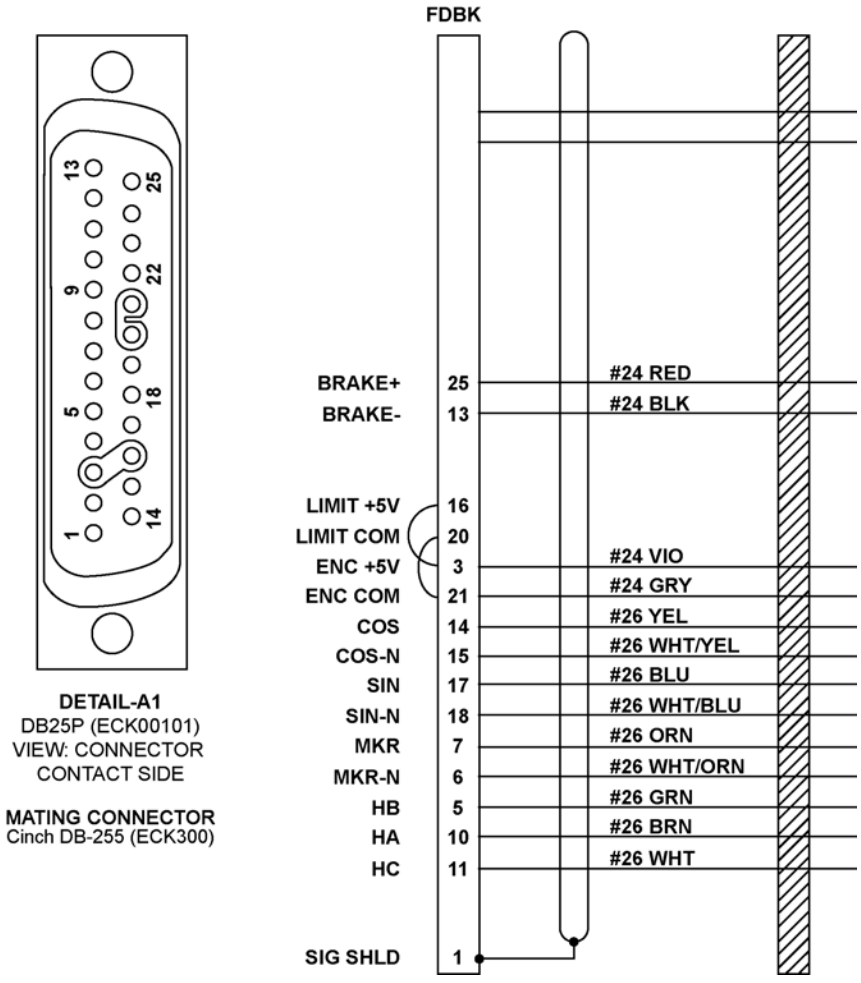


Figure 3-4: Limit, Brake, and Encoder Wiring for Standard Stages

Table 3-2: Limit, Brake, and Encoder Wiring Pinout Descriptions

Pin Output	Description
BRAKE +	Optional failsafe electro-magnetic brake +
BRAKE -	Optional failsafe electro-magnetic brake -
CCW LMT	Counter clockwise end-of-travel limit (optional)
COS	Cosine. Incremental encoder output; either TTL line driven or amplified sine wave type signal.
COS-N	Incremental encoder output. Complement of cos.
CW LMT	Clockwise end-of-travel limit (optional)
ENC +5V	+5 V supply input for optical encoders. Typical requirement is 250 mA.
HA	Hall Effect A. Brushless motor commutation track output. TTL line driven signal with rotary motor.
HB	Hall Effect B. Brushless motor commutation track output. TTL line driven signal with rotary motor.
HC	Hall Effect C. Brushless motor commutation track output. TTL line driven signal with rotary motor.
HOME LMT	Homing cycle reference limit (optional)
LMT +5v	+ 5 V supply input for optical limit switch boards. Typical requirement is 50 mA.
LMT COM	Common ground for limit switch
MKR	Marker. Incremental encoder output pulse given once per revolution. Typically used for home reference cycle.
MKR-N	Incremental encoder output; either the compliment of Marker with a line driven, TTL type encoder or 2.5 V DC bias level with amplified sine wave type encoder.
SIN	Sine. Incremental encoder output; either TTL line driven or amplified sign wave type signal.
SIN-N	Incremental encoder output. Complement of sin.

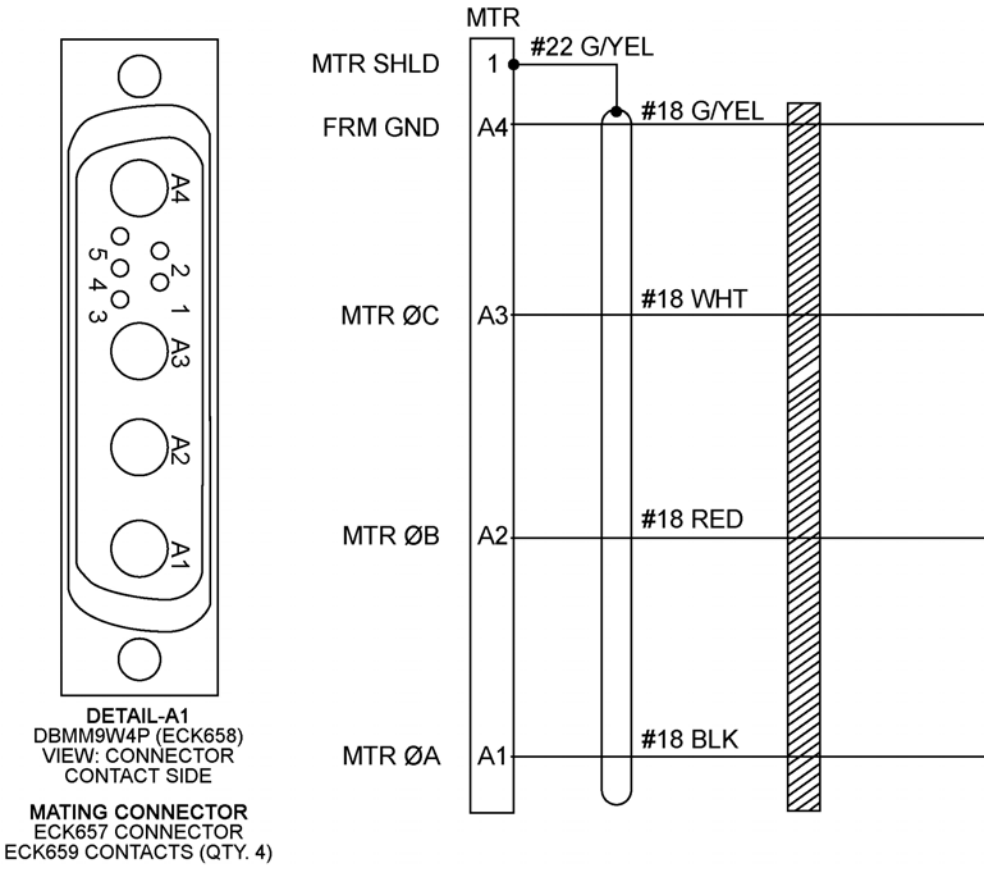


Figure 3-5: Motor Wiring Connector for all Stages

Table 3-3: Motor Wiring Pinout Descriptions

Pin Output	Description
FRM GND	Ground to stage base.
MTR SHLD	Shield for motor wiring connector.
MTR ØA	Motor Phase A.
MTR ØB	Motor Phase B.
MTR ØC	Motor Phase C.

Table 3-4: Connectorized USER/IO Cable Pin Assignments

Pin	Assignment
1	Cable Shield
2	User connection #1 (1 amp. maximum current, 50 volts maximum)
3	User connection #2 (1 amp. maximum current, 50 volts maximum)
4	User connection #3 (1 amp. maximum current, 50 volts maximum)
5	User connection #4 (1 amp. maximum current, 50 volts maximum)
6	User connection #5 (1 amp. maximum current, 50 volts maximum)
7	User connection #6 (1 amp. maximum current, 50 volts maximum)
8	User connection #7 (1 amp. maximum current, 50 volts maximum)
9	User connection #8 (1 amp. maximum current, 50 volts maximum)
10	User connection #9 (1 amp. maximum current, 50 volts maximum)
11	User connection #10 (1 amp. maximum current, 50 volts maximum)
12	User connection #11 (1 amp. maximum current, 50 volts maximum)
13	User connection #12 (1 amp. maximum current, 50 volts maximum)
14	User connection #13 (1 amp. maximum current, 50 volts maximum)
15	User connection #14 (1 amp. maximum current, 50 volts maximum)
16	User connection #15 (1 amp. maximum current, 50 volts maximum)
17	User connection #16 (1 amp. maximum current, 50 volts maximum)
18	User connection #17 (1 amp. maximum current, 50 volts maximum)
19	User connection #18 (1 amp. maximum current, 50 volts maximum)
20	User connection #19 (1 amp. maximum current, 50 volts maximum)
21	User connection #20 (1 amp. maximum current, 50 volts maximum)
22	User connection #21 (1 amp. maximum current, 50 volts maximum)
23	User connection #22 (1 amp. maximum current, 50 volts maximum)
24	User connection #23 (1 amp. maximum current, 50 volts maximum)
25	User connection #24 (1 amp. maximum current, 50 volts maximum)

3.8. Vacuum Operation

Aerotech can specially prepare the Cartesius-SD system for operation in vacuum environments. Aerotech offers two vacuum preparation options; one for low vacuum (for use in atmospheric pressures to 10^{-3} torr) and one for high vacuum (preparation for environments from 10^{-3} to 10^{-6} torr). As part of this preparation, attention to detail during modification, cleaning, and assembly results in stages with optimal performance in vacuum applications. This section will outline preparation techniques for stages that will operate in a vacuum. Some techniques covered are:

- Lubrication with vacuum–compatible lubricants
- Use of materials, fasteners, and coatings with vacuum outgas performance compatible with the level of vacuum specified
- For high vacuum stages, elimination of situations that may allow gases to become temporarily trapped during pump down
- Extensive cleaning prior to assembly in a clean environment and packaging in a special polyethylene bag

3.8.1. Special Guidelines

To ensure that the stage will continue to perform well in the vacuum environment, follow the guidelines listed below (in addition to standard handling, installation, and lubrication guidelines outlined earlier in this manual).

1. Do not remove the stage from the sealed bag until it is ready for use.
2. Always handle the stage in a clean environment and use powder-free polyethylene gloves to prevent any contaminants from adhering to the surface of the stage.
3. During installation, use cleaned, vented, stainless steel fasteners when securing the stage.
4. Reduced air pressure eliminates significant convective heat transfer. This, coupled with the viscous vacuum–compatible lubricants, could result in excessive motor operating temperatures. Because of this, consider all continuous torque ratings to be 40 to 60% lower than the value specified for operation in normal atmospheric environment. Reduce motor usage accordingly.
5. For vacuum applications, the recommended lubricant is a small quantity of Braycote® 602EF grease or a substitute of equal quality.

Baking vacuum components between 100 and 125 °C for 24 to 48 hours significantly reduces outgassing at initial pump-down to vacuum pressure and evaporates water vapor that impregnates porous surfaces on the aluminum surfaces and Teflon cables. Aerotech recommends that customers bake out vacuum systems when first installing them in the vacuum chamber.

Chapter 4: Maintenance

This chapter will cover information about intervals between lubrications, detail the lubrication and inspection process, and cover which lubricants are recommended for use.

NOTE: The bearing area must be kept free of foreign matter and moisture; otherwise, the performance and life expectancy of the system will be reduced. Always operate the system with all hard covers and side seals in place to help keep dirt out.

To minimize the possibility of bodily injury, confirm that all electrical power is disconnected prior to making any mechanical adjustments.

4.1. Service and Inspection Schedule

Lubricant inspection and replenishment in the Cartesius-SD series systems depends on conditions such as duty cycle, speed, and the environment. An inspection interval of once per month is recommended until a trend develops for the application. Longer or shorter intervals may be required to maintain the film of lubricant on the bearing surfaces. In general, it is recommended that stages operating in a clean environment be lubricated annually, or every 500 km, whichever comes first. For stages operating under conditions involving excessive debris, lubrication every six months is recommended. If the application process uses only a small portion of travel for most of the duty cycle, it is recommended that the stage be periodically driven through full travel to redistribute the lubrication in the bearings and ballscrew. The ballscrew end bearings and motor bearings are sealed, and should not need to be relubricated under normal use.

4.2. Cleaning and Lubrication

4.2.1. Recommended Lubricants and Cleaning Solvents

For standard ballscrew assemblies and LMG guide rails, THK AFE-CA grease is recommended.

If a solvent is necessary for cleaning the stage, it is recommended that isopropyl alcohol be used. Harsher solvents, such as acetone, may damage the plastic and rubber seals on the ballscrew nuts or LMG trucks. If acetone is required, avoid the screw and bearing seals.

For high-speed applications (i.e., near maximum speed at a duty cycle of 50%), frequent ballscrew maintenance with standard lubricants is required.

4.2.2. Important Notes on Lubrication

When cleaning and/or lubricating components of the Cartesius-SD:

- Be sure to use a clean, dry, soft, lint–free cloth for cleaning.
- Take the opportunity during the lubrication procedure to inspect the linear motion guides for any damage or signs of wear.
- The orthogonality may be lost if the inter-axis bolts are loosened. Precision aligned stages should not be loosened or disassembled.
- Further disassembly of the system is not recommended because proper assembly and calibration can only be done at the factory. In addition, a laser interferometer is required for post assembly verification to maintain warranties.

4.2.3. Lubrication and Cleaning Process

The lubrication and cleaning process is outlined in the steps that follow. Follow the procedure for each individual axis. Before beginning lubrication, see Section 4.2.1. for recommended lubricants.

Follow the steps below for each axis individually. For Cartesius-SD Y-axes, the motor cover will have to be removed to gain access to the hardcover mounting screws. Remove the motor cover as shown in Figure 4-1 and Figure 4-2. For Cartesius-SD Z-axes (depending on customer assembly configuration) it may not be possible to remove the hardcover by sliding it out of the side opposite the motor, as the work area may be in the way. In this case, the hardcover can be removed from the motor end, although the cover must be angled above the front end plate to be removed. Do not remove the stage tabletop. Drive the stage carriage to the far end of travel, opposite the motor, before performing this procedure. Once the hardcovers for the Cartesius-SD Y and Z-axes have been removed, clean and lubricate as described below.

Step 1: Drive the stage table to one end of travel (Figure 4-3) and remove power to the stage.

Step 2: Remove the screws on the edges of the hard cover (Figure 4-4) and slide it out from the side opposite of the motor (Figure 4-5). This can be done without removing the table.

Step 3: Remove any accumulated dust or debris from the inside of the assembly.

Step 4: Remove any dirty or dried lubricant from the ballscrew. Use a clean, lint-free cloth with a side-to-side motion. Manually turn the ballscrew to clean its entire circumference. A swab soaked in Isopropyl Alcohol may be used to remove stubborn debris.

Step 5: Clean the end of the ballscrew nut and wiper with a clean, lint-free cloth or swab.

Step 6: Clean the linear bearing guides using a similar technique.

Step 7: Apply a thin, continuous film of lubricant to the ballscrew threads and linear bearing guides. A good quality, natural bristle artist's brush makes an excellent applicator.

Step 8: For stages without an optional brake, manually move the stage to the opposite end of travel. This will work the grease into the ballscrew and linear bearing guides. If the stage has an optional brake, the stage cannot be moved by hand. In this case, restore power to the stage, drive it to the desired position, then remove power and continue to Step 9. Be sure to use extreme caution while operating the stage temporarily without the hardcover installed.

Step 9: Repeat steps 3 through 7 for any areas covered by the original table position.

Step 10: Refasten the hardcover.

Step 11: Restore power to the stage; drive the stage table back to its original position to redistribute lubricants.

To minimize the possibility of bodily injury, confirm that all electrical power is disconnected prior to making any mechanical adjustments.

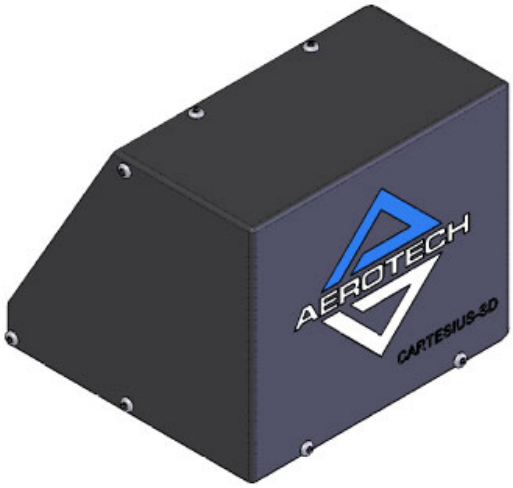


Figure 4-1: Y-axis Motor Cover

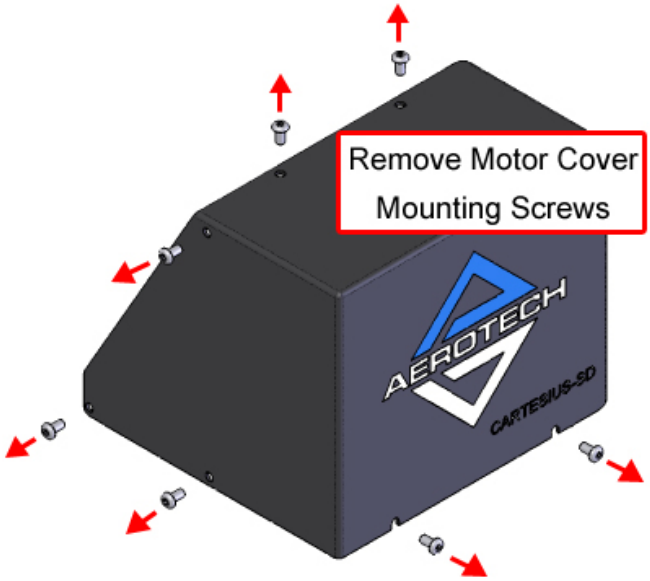


Figure 4-2: Y-axis Motor Cover Removal Procedure

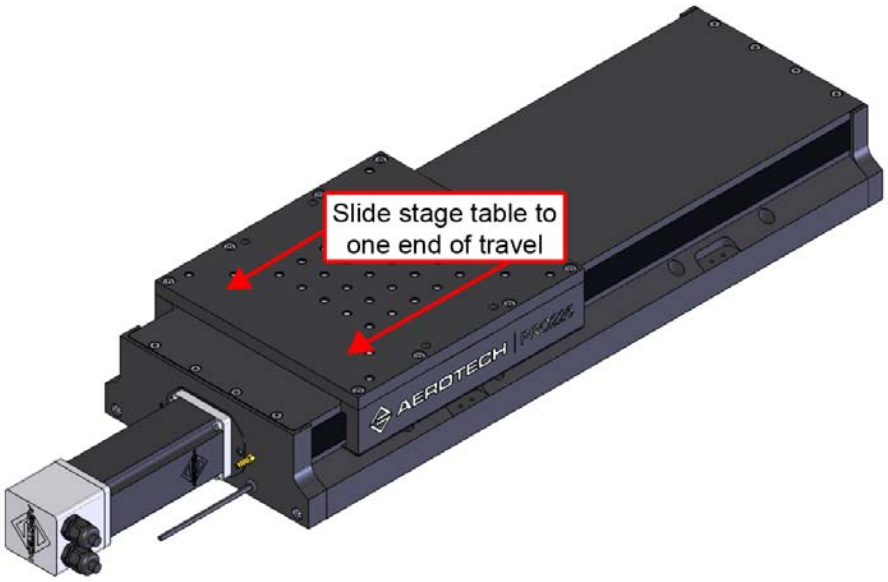


Figure 4-3: Hardcover Removal Procedure (Step 1)

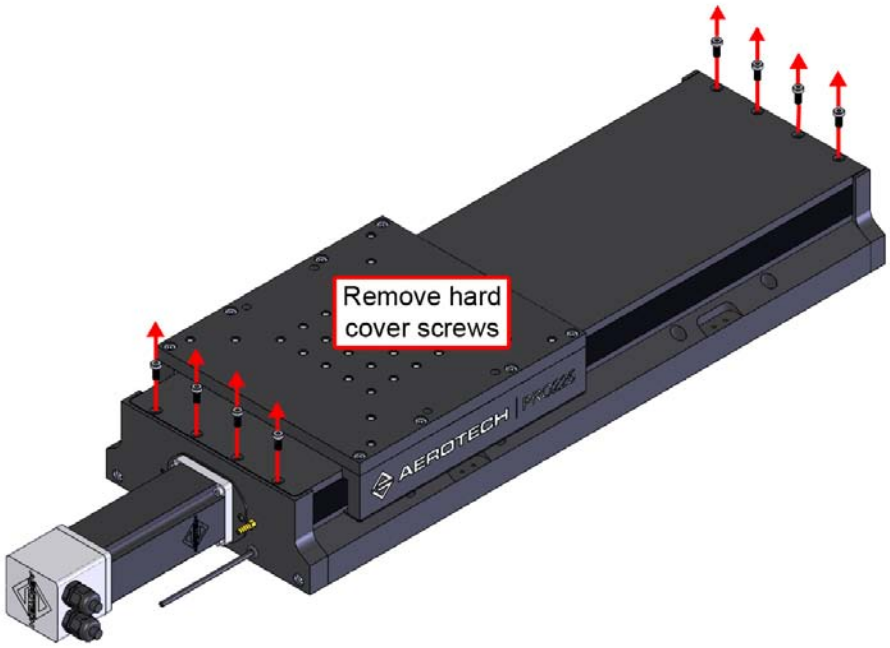


Figure 4-4: Hardcover Removal Procedure (Step 2)

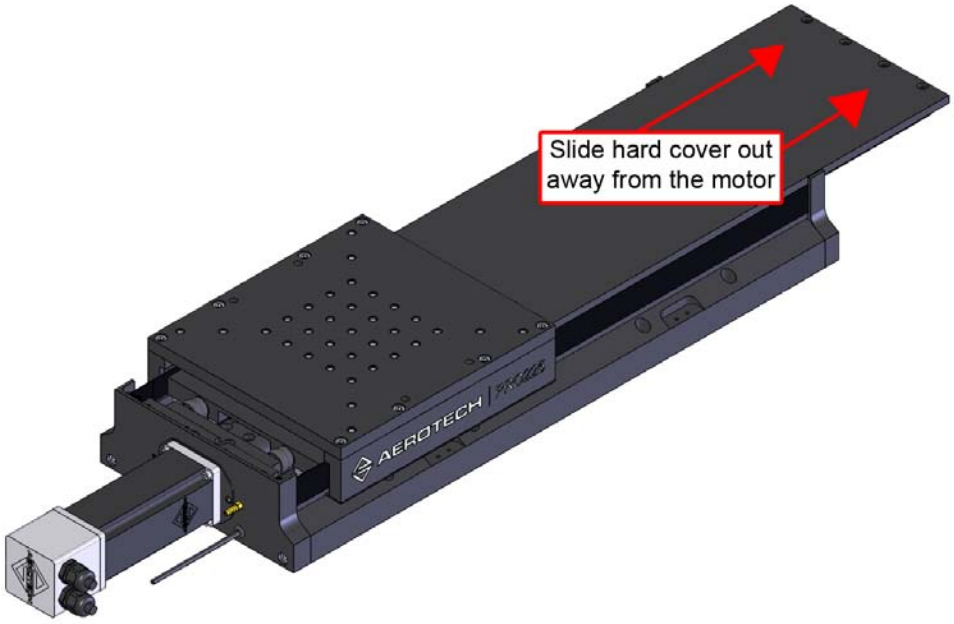


Figure 4-5: Hardcover Removal Procedure (Step 3)

Appendix A: Warranty and Field Service

Aerotech, Inc. warrants its products to be free from defects caused by faulty materials or poor workmanship for a minimum period of one year from date of shipment from Aerotech. Aerotech's liability is limited to replacing, repairing or issuing credit, at its option, for any products that are returned by the original purchaser during the warranty period. Aerotech makes no warranty that its products are fit for the use or purpose to which they may be put by the buyer, where or not such use or purpose has been disclosed to Aerotech in specifications or drawings previously or subsequently provided, or whether or not Aerotech's products are specifically designed and/or manufactured for buyer's use or purpose. Aerotech's liability or any claim for loss or damage arising out of the sale, resale or use of any of its products shall in no event exceed the selling price of the unit.

Laser Products

Aerotech, Inc. warrants its laser products to the original purchaser for a minimum period of one year from date of shipment. This warranty covers defects in workmanship and material and is voided for all laser power supplies, plasma tubes and laser systems subject to electrical or physical abuse, tampering (such as opening the housing or removal of the serial tag) or improper operation as determined by Aerotech. This warranty is also voided for failure to comply with Aerotech's return procedures.

Return Procedure

Claims for shipment damage (evident or concealed) must be filed with the carrier by the buyer. Aerotech must be notified within (30) days of shipment of incorrect materials. No product may be returned, whether in warranty or out of warranty, without first obtaining approval from Aerotech. No credit will be given nor repairs made for products returned without such approval. Any returned product(s) must be accompanied by a return authorization number. The return authorization number may be obtained by calling an Aerotech service center. Products must be returned, prepaid, to an Aerotech service center (no C.O.D. or Collect Freight accepted). The status of any product returned later than (30) days after the issuance of a return authorization number will be subject to review.

Returned Product Warranty Determination

After Aerotech's examination, warranty or out-of-warranty status will be determined. If upon Aerotech's examination a warranted defect exists, then the product(s) will be repaired at no charge and shipped, prepaid, back to the buyer. If the buyer desires an airfreight return, the product(s) will be shipped collect. Warranty repairs do not extend the original warranty period.

Returned Product Non-warranty Determination

After Aerotech's examination, the buyer shall be notified of the repair cost. At such time, the buyer must issue a valid purchase order to cover the cost of the repair and freight, or authorize the product(s) to be shipped back as is, at the buyer's expense. Failure to obtain a purchase order number or approval within (30) days of notification will result in the product(s) being returned as is, at the buyer's expense. Repair work is warranted for (90) days from date of shipment. Replacement components are warranted for one year from date of shipment.

Rush Service

At times, the buyer may desire to expedite a repair. Regardless of warranty or out-of-warranty status, the buyer must issue a valid purchase order to cover the added rush service cost. Rush service is subject to Aerotech's approval.

On-site Warranty Repair If an Aerotech product cannot be made functional by telephone assistance or by sending and having the customer install replacement parts, and cannot be returned to the Aerotech service center for repair, and if Aerotech determines the problem could be warranty-related, then the following policy applies:

Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs. For warranty field repairs, the customer will not be charged for the cost of labor and material. If service is rendered at times other than normal work periods, then special service rates apply.

If during the on-site repair it is determined the problem is not warranty related, then the terms and conditions stated in the following "On-Site Non-Warranty Repair" section apply.

On-site Non-warranty Repair If any Aerotech product cannot be made functional by telephone assistance or purchased replacement parts, and cannot be returned to the Aerotech service center for repair, then the following field service policy applies:

Aerotech will provide an on-site field service representative in a reasonable amount of time, provided that the customer issues a valid purchase order to Aerotech covering all transportation and subsistence costs and the prevailing labor cost, including travel time, necessary to complete the repair.

Company Address

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Appendix B: Technical Changes

Table B-1: Current Changes (1.01.00)

Section(s) Affected	General Information
Section 1.4.	Section added
Section 3.1.	Section added
Chapter 2: Installation, Section 2.1. , Section 2.4. , Section 2.6. , and Section 1.3.	Added safety information and warnings
Section 3.7.	Added note about wire current and voltage requirements

Table B-2: Archived Changes

Revision	Section(s) Affected	General Information
1.00.00	--	New manual

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Reader's Comments

Cartesius-SD Series Stage Manual **P/N: EDS141, November 29, 2010** **Revision 1.01.00** Please answer the questions below and add any suggestions for improving this document.	

Is the manual:	Yes	No
Adequate to the subject		
Well organized		
Clearly presented		
Well illustrated		

How do you use this document in your job? Does it meet your needs? What improvements, if any, would you like to see? Please be specific or cite examples.

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